PB88-106133

Superfund

(U.S.) Environmental Protection Agency
Cincinnati, OH

Sep 87

U.S. Department of Commerce
National Technical Information Service
NTIS

PB88-106133

EPA/600/D-87/293
September 1987

SUPERFUND

By

Ronald D. Hill
Hazardous Waste Engineering Research Laboratory
U.S. Environmental Protection Agency
Cincinnati, OH 45268

HAZARDOUS WASTE ENGINEERING RESEARCH LABORATORY
OFFICE OF RESEARCH AND DEVELOPMENT
U.S. ENVIRONMENTAL PROTECTION AGENCY
CINCINNATI, OH 45268

REPRODUCED BY
U.S. DEPARTMENT OF COMMERCE
NATIONAL TECHNICAL
INFORMATION SERVICE
SPRINGFIELD, VA 22161

TECHNICAL REPORT DATA *(Please read Instructions on the reverse before completing)*		
1. REPORT NO. EPA/600/D-87/293	2.	3. RECIPIENT'S ACCESSION NO.
4. TITLE AND SUBTITLE Superfund		5. REPORT DATE September 1987 6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S) Ronald D. Hill		8. PERFORMING ORGANIZATION REPORT NO.
9. PERFORMING ORGANIZATION NAME AND ADDRESS Hazardous Waste Engineering Research Laboratory Office of Research and Development 26 W. St. Clair Street Cincinnati, Ohio 45268		10. PROGRAM ELEMENT NO. 11. CONTRACT/GRANT NO.
12. SPONSORING AGENCY NAME AND ADDRESS Hazardous Waste Engineering Research Laboratory Office of Research and Development U.S. Environmental Protection Agency Cincinnati, Ohio 45268		13. TYPE OF REPORT AND PERIOD COVERED Book Chapter 14. SPONSORING AGENCY CODE EPA/600/12
15. SUPPLEMENTARY NOTES		

16. ABSTRACT

This chapter covers the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and its amendments. CERCLA is a very comprehensive law, directing the USEPA, other Federal agencies, and the states on how to collect and manage the "fund," conduct cleanups, encourage private cleanups, and recover the costs of Federally-supported actions. The 1980 legislation established a fairly straightforward structure to obtain these goals. The 1986 amendments did not fundamentally alter the structure, but added far more detail than was present in the original law and added some additional requirements and provisions. The procedures for placing a site on the National Priority List, conducting preliminary assessment, removal action, remedial investigations, and feasibility studies are discussed.

17. KEY WORDS AND DOCUMENT ANALYSIS		
a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
18. DISTRIBUTION STATEMENT Release to Public	19. SECURITY CLASS *(This Report)* Unclassified 20. SECURITY CLASS *(This page)* Unclassified	21. NO. OF PAGES 30 22. PRICE

EPA Form 2220-1 (Rev. 4-77) PREVIOUS EDITION IS OBSOLETE

NOTICE

This document has been reviewed in accordance with U.S. Environmental Protection Agency policy and approved for publication. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

OUTLINE

SUPERFUND CHAPTER

by

Ronald D. Hill

1. Introduction

    a. CERCLA
    b. SARA
    c. Program to date

2. Overview of CERCLA and SARA

3. Releases, Hazardous Substances, Reportable Quantities

4. National Contingency Plan

5. Discovery and Notification

6. Preliminary Assessment and Evaluation

7. Removal Actions

8. Site Evaluation and National Priority List

9. RI/FS (Cleanup Standards)

10. Record of Decision

11. Remedial Actions

12. Glossary of Acronyms

13. Appendix A

    a. Hazardous waste (list of lists)
    b. Reportable quantities

SUPERFUND

by
Ronald D. Hill
Hazardous Waste Engineering Research Laboratory
U.S. Environmental Protection Agency
Cincinnati, Ohio 45268

INTRODUCTION

In response to public concern over poor past disposal practices of hazardous wastes and the thousands of uncontrolled waste sites throughout the United States, in December 1980 Congress enacted the Comprehensive Environmental Response, Compensation and Liability Act, PL 96-510,[1] commonly known as CERCLA, or Superfund. This Act was a result of the wide publicity that sites such as Love Canal, Valley of the Drums, and Stringfellow had received that made the public aware that uncontrolled hazardous waste sites were either causing harm to the public health and environment or were a potential threat in the future.

The Superfund Act was enacted in part by the recognition that the Resource Conservation and Recovery Act, commonly referred to as RCRA or Solid Waste Act, provided a regulatory program for active hazardous waste facilities, but not inactive sites. Superfund provided a Federal response to uncontrolled releases of hazardous substances from a vessel or from any onshore or offshore facility. A key feature of the Act was the establishment of a trust fund to support the cleanup activities. This fund received $1.6 billion over a 5-year period. The revenue was supported 87.5 percent by taxes on petroleum and chemical feedstock, and 12.5 percent from a Treasury appropriation. This authority ran out in December 1985. After almost a year without new authority, extensive amendments known as the Superfund Amendments and Reauthorization Act, PL 99-499,[2] called SARA, was adopted in October 1986. This Act established a new fund of $8.5 billion over a 5-year period beginning January 1, 1987. The principal sources of revenue will be a tax on petroleum, 42 listed chemicals, a broad-based corporate environmental tax, and appropriations from general revenues.

Although the U.S. Environmental Protection Agency (USEPA) has been severely criticized by Congress for lack of action in the cleanup of hazardous waste sites, its record of activities during the first 5 years has been extensive.[3] The USEPA developed an inventory of 25,194 hazardous waste sites throughout the United States. A preliminary assessment of 20,023 was made. A total of 1,477 sites was scored using the Hazardous Ranking System to evaluate the health and environmental threat posed by the sites. The USEPA placed 703 sites on the National Priority List (NPL) and 185 more sites were proposed for listing. Since this report, even more sites have been proposed. Some form of response action had been taken at 1,174 sites and emergency response actions, often called removal actions, had been commenced at 808 sites. Of these sites, 611 had been financed by the Government, 150 by the potentially responsible parties (PRP), and 47 by both the USEPA and the PRP's. Remedial Investigations and Feasibility Studies (RI/FS) were begun at 468 sites and long-term remedial actions were completed at 14 NPL sites. The value of PRP response actions was estimated at $818 million.

OVERVIEW OF CERCLA AND SARA

As specified in its name, CERCLA is a very comprehensive law, directing the USEPA, other Federal agencies, and the states on how to collect and manage the "fund," conduct cleanups, encourage PRP's to conduct their own cleanups, and recover the costs of Federally supported actions from the PRP's. The 1980 legislation established a fairly straightforward structure to obtain these goals. The 1986 SARA amendments did not fundamentally alter the structure, but added far more detail than was present in the original law and added some additional requirements and provisions. In fact, the length of the amendments exceeded that of the original law.

The detailed new provisions speak of such issues as "how clean is clean," by defining cleanup standards and a preference for permanent treatment and on-site remedies. Deadlines with specific numbers of actions that must be taken for evaluating sites, placing them on the NPL, and undertaking response actions are included. Health effects study requirements, applicable to every site on the NPL, were added. A new title was added on emergency planning and community right-to-know in response to concerns raised over catastrophic releases of toxic chemicals, e.g., the Bhopal, India, disaster where 2,500 people were killed.

RELEASES, HAZARDOUS SUBSTANCES, REPORTABLE QUANTITIES

Section 103 of Superfund specifies that responsible parties must report to the Federal Government's National Response Center (800/424-8802) any spill or other release of a hazardous substance to the environment in a reportable quantity. Congress defines a "release" as any spill, leaking, pumping, pouring, emitting, emptying, discharging, injecting, escaping, leaching, dumping, or disposing into the environment, including the abandonment or discharging of barrels, containers, and other closed receptables containing any hazardous substance, pollutant, or contaminant.[2]

What is a "hazardous substance"? Superfund defines a "hazardous substance" as (1) any substance designated as a hazardous pollutant under Section 311 of the Clean Air Act; (2) any toxic pollutant listed under Section 307(a) of the Clean Water Act; (3) any hazardous air pollutant listed under Section 112 of the Clean Air Act; (4) any hazardous waste under RCRA; (5) any imminently hazardous chemical substance or mixture with regard to which the USEPA Administrator has taken action under Section 7 of the Toxic Substances Control Act (TSCA); and (6) any substance designated as hazardous under Section 102 of Superfund. When all of these lists were combined into a "list of lists," 717 hazardous substances were identified.[4] The "list of lists" is presented in Appendix A.

The term "hazardous substance" does not include petroleum, natural gas, or synthetic gas of pipeline quality. In addition, certain solid wastes are suspended from regulation. These include solid waste from the extraction, beneficiation, and processing of ores and minerals, cement kiln dust, and waste generated from the combustion of coal or other fossil fuels.

Superfund also requires the USEPA to establish regulations on "reportable quantities." This requirement establishes the quantity for each hazardous substance, the release of which shall be reported. "Reportable quantities" have been promulgated for 442 hazardous substances based on scientific criteria relating to the risk posed by a release of that substance (Appendix A).[4] The USEPA is evaluating the remaining 275 hazardous substances for potential carcinogenicity and chronic toxicity. Until the USEPA sets a reportable quantity for these substances, the quantity previously established under Section 311 of the Clean Water Act, or, if none exists, the reportable quantity is 1 pound.

The reportable quantities start at 1 pound for many substances and range up to 5,000 pounds for substances such as chloroform, carbon tetrachloride, and hydrochloric acid. For mixtures and solutions there is a "release" when a component hazardous substance is in the mixture or solution in its reportable quantity.

NATIONAL CONTINGENCY PLAN (NCP)

The cornerstone of the removal and remedial program of Superfund is the NCP. Section 105 of Superfund [1,2] specifies the content of this plan. The plan establishes the procedures and standards for responding to releases of hazardous substances, pollutants, and contaminants. In addition, it contains the National Priorities List (NPL). This list contains those sites that present the greatest danger to public health and welfare or the environment, and thus are eligible for cleanup action under Superfund. The NCP includes matters such as:

1. Methods for discovering and investigating facilities at which hazardous substances have been disposed or otherwise came to be located;

2. Methods for evaluating, including analyses of relative cost, and remedying any releases or threats of releases from facilities which pose substantial danger to the public health or the environment;

3. Methods and criteria for determining the appropriate extent of removal, remedy, and other measures;

4. Appropriate roles and responsibilities for the Federal, state, and local governments, and for interstate and nongovernmental entities in effectuating the plan;

5. A method for and assignment of responsibility for reporting the existence of such facilities which may be located on federally-owned or controlled properties; and

6. Criteria for determining priorities among releases or threatened releases throughout the United States (Hazard Ranking System, (HRS)).

The NCP was substantially revised and last reissued in November 1985.[5] SARA requires several changes in the NCP and a revised plan will be issued by the USEPA in 1987 and 1988.

There are seven phases for determining the appropriate response to a release of hazardous substances:

1. Discovery and notification
2. Preliminary assessment and evaluation
3. Removal actions
4. Site evaluation and NPL determination
5. Community relations
6. Remedial action
7. Documentation and cost recovery

DISCOVERY AND NOTIFICATION

The response to a hazardous release starts when the USEPA is informed that a release has occurred or is imminent. This notification can come from several sources including: a notification to the National Response Center; notification by the owners or operators of a facility; or through investigations by state and Federal government authorities. Over 25,000 sites have been identified in this manner.[3]

PRELIMINARY ASSESSMENT AND EVALUATION

A notification of a release will result in the USEPA undertaking a preliminary assessment to evaluate the need for a "response action." The assessment includes an evaluation of the magnitude of the hazard, the identification of any party or parties who are ready, willing, and able to undertake a response action, and an evaluation of whether immediate removal is necessary. Readily available information and data are reviewed at this stage. Available records, photographs, etc., are collected and personal interviews are made. A perimeter inspection of the site to assess the potential for a release may also be taken.

The preliminary assessment will be terminated when it is determined that there has been no release; the release does not involve a hazardous substance, pollutant, or contaminant; the amount released does not require a federal response; a responsible party is providing an appropriate response; or the assessment is completed.

If the assessment indicates that a "removal action" is necessary, (Removal Actions are discussed in the next section), then the USEPA is required to identify responsible parties and have them conduct a removal action or conduct the removal themselves. If the assessment indicates a "remedial action" is necessary, then the procedures specified in the NCP for a remedial action is undertaken.

REMOVAL ACTIONS

Removal actions are undertaken when the USEPA determines that there is a threat to public health or welfare, or the environment. This determination is made after reviewing the following factors:

1. Is there an actual or potential exposure by hazardous substances or contaminants to nearby populations, animals, or food chains?

2. Is there an actual or potential contamination of drinking water supplies or sensitive ecosystems?

3. Is there a hazardous substance or pollutant, or contaminants in drums, barrels, tanks, or other bulk storage containers that may pose a threat of release?

4. Is there a threat of fire or explosion?

5. Are there high levels of hazardous substances and soils that may migrate?

6. Are there weather conditions that may cause hazardous substances to migrate?

The purpose of a removal action is to abate, minimize, stabilize, mitigate, or eliminate a public health threat. In essence, a removal action is usually done to abate the immediate threat of a hazardous waste to the public health or environment. It usually does not lead to a complete cleanup of a site. The complete cleanup follows the procedures described in the NCP.

Removal actions may include as simple an action as the installation of a security fence and warning signs to prevent access of humans and animals to the release or destruction of the waste on-site, or the removal of the waste to approved RCRA facilities for treatment or disposal. Removal actions have included activities such as installation of drainage controls to prevent runoff of contaminated waters; capping of contaminated soils and sludges, segregation and storage of drummed wastes, removal of highly contaminated soils, sludges, or drums; providing alternative water supplies; and incineration or treatment of waste on-site.

SARA places a limit on removal actions of 2 million dollars and/or the lapse of 12 months from the date of the initial removal, unless it is found that circumstances warrant continued action. Because of the "emergency" nature of removal actions, they are not required to meet other federal, state, or local requirements such as obtaining permits. However, removal actions are required to the greatest extent practicable to meet or exceed applicable or relevant and appropriate federal public health and environmental requirements.

If the removal action does not sufficiently abate the threat, an orderly transition from a removal to a remedial action occurs. By mid-1986, the USEPA had commenced removal actions at 808 sites.

SITE EVALUATION AND NATIONAL PRIORITY LIST

Those sites that the USEPA decides warrant further evaluation after completion of a preliminary assessment undergo a site inspection (SI).[6] SI's generally include on-site and off-site observations and sampling to identify the presence of hazardous substances and to determine whether off-site migration has occurred. The SI should complete the collection of data so that an evaluation of the threat to public health and the environment can be determined. This model is called the Hazard Ranking System (HRS).

The HRS is one of the most significant processes under Superfund because the decision to list or not list a particular site on the National Priority List is based on the HRS ranking. An HRS listing of a site assures evaluation of that site to determine the exact nature and extent of the risk that it presents and the most effective remediation alternative, i.e., the Remedial Investigation/Feasibility Study (RI/FS) process. Listing a site also means that federal fund money could be spent on the site and that potentially responsible parties (PRP) will be identified for cleanup cost or action.

The HRS[7] evaluates relative risk among hazardous waste sites. Risk is a composite measure of the probability and magnitude of adverse effects, and is specified in terms of what the risks are and who is at risk. In the first case, the concern is the "risk of" a release, exposure, health effect, and/or ecological damage. The second case is the "risk to" an individual, a population group, and an environmental resource. A hazardous waste site usually poses a variety of risks to a variety of targets, and the HRS is intended to rank sites in terms of their overall relative risk to humans and the environment. A uniform application of the ranking system enables EPA to make a technical judgment regarding the potential hazards presented by a facility relative to other facilities. It does not address the feasibility, desirability, or degree of cleanup required.

The HRS assigns three scores to a hazardous facility:

- S_M reflects the potential for harm to humans or the environment from migration of a hazardous substance away from the facility by routes involving groundwater, surface water, or air. It is a composite of separate scores for each of the three routes.
- S_{FE} reflects the potential for harm from substances that can explode or cause fires.
- S_{DC} reflects the potential for harm from direct contact with hazardous substances at the facility (i.e., no migration need be involved).

The score for each hazard mode (migration, fire and explosion, and direct contact) or route is obtained by considering a set of factors that characterize the potential of the facility to cause harm (Table 1). Each factor is assigned a numerical value (on a scale of 0 to 3, 5, or 8) according to prescribed guidelines. This value is then multiplied by a weighting factor yielding the factor score. The factor scores are then combined: scores within a factor category are added; then the total scores for each factor category are multiplied together to develop a score for groundwater, surface water, air, fire and explosion, and direct contact.

In computing S_{FE}, S_{DC}, or an individual migration route score, the product of individual category scores is divided by the maximum possible score, and the resulting ratio is multiplied by 100. The last step puts the score on a scale of 0 to 100.

S_M is a composite of the scores for the three possible migration routes:

$$S_M = \frac{1}{1.73} \sqrt{S_{gw}^2 + S_{sw}^2 + S_a^2}$$

where: S_{gw} = groundwater route score
S_{sw} = surface water route score
S_a = air route score

The effect of this means of combining the route scores is to emphasize the primary (highest scoring) route in aggregating route scores while giving some additional consideration to the secondary or tertiary routes if they score high. The factor 1/1.73 is used simply for the purpose of reducing S_M scores to a 100-point scale.

The HRS does not quantify the probability of harm from a facility or the magnitude of the harm that could result, although the factors have been selected in order to approximate both those elements of risk. It is a procedure for ranking facilities in terms of the potential threat they pose by describing:

- the manner in which the hazardous substances are contained,
- the route by which they would be released,
- the characteristics and amount of the harmful substances, and
- the likely targets

The multiplicative combination of factor category scores is an approximation of the more rigorous approach in which one would express the hazard posed by a facility as the product of the probability of a harmful occurrence and the magnitude of the potential damage.

The ranking of facilities nationally for remedial action will be based primarily on S_M. S_{FE} and S_{DC} may be used to identify facilities requiring emergency attention. Details on the calculation of HRS scores are presented in Reference 7.

The Superfund Amendments (SARA) required EPA within 18 months after the enactment of the Act to amend the HRS to assure, to the maximum extent feasible, that the hazard ranking system accurately assess the relative degree of risk to human health and the environment posed by sites and facilities subject to review. The amended HRS should become effective within 24 months of the enactment or no later than October 1988.

As of June 1986,[8] 703 sites had been placed on the National Priority List and another 185 sites had been proposed (Figure 1). Table 2 presents a list of the NPL sites by state/territory. New Jersey, Michigan, New York, Pennsylvania, and California lead the list with 97, 66, 65, 65, and 61 respectively. Figure 2 and Table 3 show the types of activities at each of the 888 sites and Figure 3 shows the observed contamination.

REMEDIAL INVESTIGATION/FEASIBILITY STUDY (RI/FS)

Once a site has been placed on the NPL, the U.S. EPA, a state, or the PRP's will conduct a Remedial Investigation (RI) and prepare a Feasibility Study (FS) leading to a decision for a remedial action or "no-action." Remedial actions are responses to releases that preferably result in a permanent remedy. The RI/FS is used by EPA to determine the nature and extent of the threat and to evaluate and select a remedy.

The remedial investigation and the feasibility study are interdependent. The activities comprising these two projects are generally performed concurrently rather than sequentially. The remedial investigation emphasizes data collection and site characterization, whereas the feasibility study emphasizes data analysis and decision-making.

The remedial investigation is conducted concurrently with the feasibility study. The remedial investigation is the data collection mechanism for the feasibility study effort; this relationship is discussed later in this chapter. The remedial investigation also supports remedial alternatives evaluation through bench and pilot studies. Figure 4 illustrates the remedial investigation process.

The initial activity in the remedial investigation is the scoping process. The scoping effort includes the collection and evaluation of existing data, identification of remedial investigation objectives, and the identification of general response actions for the feasibility study. Data needs, preliminary plans, and investigation tasks are identified. The investigation scoping process may recur or be modified as more data are collected and site characterization becomes more complete.

The scoping process is critical to the development of a sampling plan and subsequent remedial investigation. This sampling plan describes the sampling studies to be conducted, including sample types, analyses, and sampling locations and frequency. Planning needs such as sampling operational plans, materials, record-keeping, sampling team personnel needs, and sampling procedures are also developed or identified for the investigation.

Associated with the scoping and sampling plan efforts are a variety of support activities that require the preparation of specific plans or implementation of specific procedures to supplement the remedial investigation and documentation of data. Specific plans address data management procedures, including quality assurance/quality control programs; health and safety planning requirements, including development of an overall health and safety program and a site-specific health and safety plan; and may review institutional issues arising from Federal, state, and local regulations, policies, and guidelines that may affect the investigation.

Site characterization involves the collection and analysis of the data needed for the various types of assessments that are part of the investigation. Because site data and understanding vary, a multilevel approach to data collection is recommended. Each level differs in the scope of the activities. The three levels of data collection and site characterization efforts are:

- Level I - Problem Identification and Scoping. Existing site information is collected and evaluated to define the problem(s) at the site, public and environmental threats, and site features contributing to the problem(s). This assessment is conducted for all sites and provides the basis for immediate mitigation actions for defining investigation needs in levels II and III. The data collected at this level are also used in identifying and analyzing remedial technologies.

- Level II - Problem Quantification. Specific site data are collected through sampling and field studies to characterize site problems and their dimensions more fully. Sufficient data should be collected to identify contaminants of concern, to verify actual exposure pathways, and, in general, to characterize the site well enough to support, at a minimum, the screening of remedial technologies and alternatives.

- Level III - Problem Quantification and Detailed Investigation. If level II data are insufficient, additional data are collected for use in detailed analysis of remedial alternatives or in the selection of a cost-effective alternative.

The remedial investigation does not require that all three levels be completed; the process may terminate at any level provided that sufficient data have been obtained. For some sites, a level I study may furnish enough data for response decisions, particularly if a site has been well-studied or the need for an immediate response is obvious. The investigation may end at level II if characterization data are sufficient to permit the selection of a response. Alternatively, where level I analyses are sufficient to support feasibility study decisions and a level II effort is not necessary, a level III study involving bench or pilot testing may be needed to select between alternatives or finalize a design. Thus, the investigation needs vary from site to site, and the levels of the remedial investigation must be appropriate to these needs.

Bench- or pilot-scale studies may be needed in the remedial investigation to obtain enough data to select a remedial alternative. The scope of bench and pilot studies in the remedial investigation specifically addresses waste treatability, scale-up of innovative technologies, technology application issues, and evaluation of specific alternatives. Bench and pilot studies may also be conducted during remedial alternative design or construction to more fully evaluate specific requirements of the selected alternative, however, these studies are outside the remedial investigation and feasibility study process. In general, bench-scale studies are appropriate for the remedial investigation stage while pilot-scale studies, if required, may be conducted during the final design.

Figure 5 depicts the concurrent activities associated with the remedial investigation (RI) and feasibility study (FS). The upper portion of the figure consists of two flow charts illustrating the sequential, interdependent events associated with the RI/FS process. The lower portion of the figure is a tabulation of the tasks identified in the Model Statement of Work for the RI/FS. This Model Statement of Work sets forth the tasks that a contractor will perform in conducting a government-led RI/FS. The lower portion of Figure 5 also identifies the chapters in the Remedial Investigation and Feasibility Study Guidance Documents[9] that the U.S. EPA has produced.

The vertical lines on the chart indicate some of the plans, reports, or milestones recommended in the RI/FS guidance. These connectors and the listings below them illustrate the integration of the RI/FS process.

The feasibility study process is outlined in Figure 6. The first step of the feasibility study, defining the objectives of the action and broadly developing response actions, should be performed as a refinement to project scoping during the remedial investigation and should be summarized in the final remedial investigation report. There may be modification of this scoping as data are collected or as the general response actions are more fully developed during the feasibility study stage. The remedial alternatives developed at this point are general response actions which broadly define the nature of the response. In general, they should address whether source control measures designed to prevent or minimize migration of hazardous substances from the source and/or measures designed to mitigate the impact of contamination that has migrated into the environment are necessary, and what phasing of these measures may be necessary.

The next step in the process is the development of specific alternatives within the general response categories. First, technologies within the categories are screened for their technical applicability to the site. Technologies considered technically appropriate are then combined to form operable units that address one or more aspects of the identified site problems. These operable units may then be combined to form alternatives addressing the complete site. The alternatives are then screened on the basis of public health, environmental, and cost concerns.

The next five activities comprise the detailed analysis of alternatives, which is necessary to provide the decision-maker with information for selecting the alternative that is cost-effective. These activities include the engineering analysis of the alternatives in terms of constructability and reliability to ensure the implementability of the selected remedial action; an evaluation of institutional requirements such as compliance with other applicable or relevant and appropriate (ARA) Federal and State environmental statutes and community relations; an evaluation of public health protection requirements that must be met; an evaluation of environmental impacts of the action; and a detailed cost analysis.

A major issue in all remedial actions is "how clean is clean," that is, to what extent should a site be cleaned up.

Congress has provided a clear directive in SARA for the selection of a permanent action. Section 121 provides that "remedial actions in which treatment which permanently and significantly reduces the volume, toxicity, or mobility of the hazardous substances.....are to be preferred," and that off-site transport and disposal without treatment is the least favored method of completing remedial actions. This provision was adopted to discourage untreated land disposal, or simply move waste from one location to another without reducing the long-term threat. To underscore the fact that treatment is preferred over land disposal or containment, the U.S. EPA must review a site every 5 years to ensure that the final solution continues to be protective of human health and the environment if the remedial action involves leaving the hazardous substance at the site.

If hazardous substances (or pollutants or contaminants) will remain at the site, i.e., on-site remedies, the remedial action must result in a level or standard of control for the substance which at least attains the legally applicable standards, requirements, or criteria under federal environmental laws (including the Resource Conservation and Recovery Act, the Toxic Substances Control Act, the Safe Drinking Water Act, the Clean Air Act, and the Clean Water Act) or state environmental or facility siting laws that are more stringent than federal standards. If land disposal is chosen as part of the remedial action for on-site remedies, any state standard that would effectively result in a state-wide prohibition of the land disposal shall not apply except in certain narrowly-defined circumstances. No federal, state, or local permit is required for actions taken entirely on-site, if the remedial action is carried out in compliance with the cleanup standards.

If an off-site remedy is chosen, the hazardous substances must be transferred to a facility that is operating in compliance with a RCRA or other federal permit. The substances can only be sent to a land disposal facility if (a) the unit to which the substances will be sent is not releasing any hazardous wastes into the groundwater, surface water, or soil, and (b) any releases from other units at the facility are being controlled by a corrective action program.

There are six statutory exceptions to the new requirement that the remedial action meet the applicable or relevant environmental standards and criteria appropriate requirements (ARAR). These include cases where the remedial action is an operable unit and only a part of a larger action that will attain the applicable levels when completed; compliance would result in greater risk; compliance is technically impracticable; the remedial action selected will attain a standard of performance that is equivalent to the required standard; the state standard at issue has not been consistently applied within the state; and in the case of a remedial action under Section 104 using the Fund, a remedial action that complies with the standard will not provide an appropriate balance between the need for protection of public health and the environment and the monies available in the Fund.

As of late 1986, the U.S. EPA had initiated 489 RI/FS'. SARA established a mandatory time schedule for the U.S. EPA to conduct RI/FS' in the future. Within 3 years, 275 RI/FS' must be initiated and within 5 years a total of 650 RI/FS' must be initiated.

The RI/FS' conducted to date have provided some valuable information on Superfund site characteristics. Table 4 lists the substances most frequently found at sites.

RECORD OF DECISION

Once the RI/FS process is complete, the U.S. EPA selects a response action. The Agency is required to establish an administrative record called Record of Decision, or "ROD," in support of the selection of a response action for the site. The ROD serves as a basis for judicial review of Agency action and must be available to the public. Public participation must take place in the development of the ROD. The U.S. EPA is required to publish a notice and analysis of a proposed plan and allow opportunity for comments and public meetings. It also requires the final plan to be published and made available to the public before

a remedial action is begun along with a response to significant comments, criticisms, and new data. The U.S. EPA is also required to publish an explanation of any part of the completed remedial action that differs from the final plan.

As of June 1986, 126 RODs or enforcement decision documents (EDD) had been signed.

REMEDIAL ACTIONS

By the end of 1986, the U.S. EPA had completed 14 remedial actions (RA) and another 103 had been initiated. SARA mandates that 175 new RAs be initiated during the first 3 years after enactment and an additional 200 RAs be initiated during the fourth and fifth year after enactment.

Management techniques for hazardous wastes found at Superfund sites may be grouped into two broad categories--land disposal (either on-site or off-site) and use of technologies that permanently reduce or destroy the hazardous character of the waste. In general, land disposal was used more frequently than other management techniques in the first 5 years of Superfund. This is because, for many waste types, land disposal is typically less expensive than technologies which change the nature of the waste. As a result, hazardous waste management at Superfund sites has frequently relied on relatively inexpensive land disposal. This reliance has limited the development and use of typically more expensive options. The heavy reliance on land disposal of hazardous wastes is illustrated in Figure 7. This figure summarizes a review of remedial activities at 51 National Priority List (NPL) sites which revealed that on-site land disposal, including capping and on-site landfilling, was used at 52 percent of the sites and off-site land disposal was used at 54 percent of the sites.

Concern over the long-term reliability of land-based disposal practices prompted Congress to direct the Agency to give preference to providing treatment which permanently and significantly reduces the volume, toxicity, or mobility of the hazardous substance. Since technology is not readily available for many Superfund problems, SARA authorized a research, development, and demonstration program. The U.S. EPA established the Superfund Innovative Technology Evaluation (SITE) program to find better solutions to hazardous waste cleanup.[11] As part of the SITE program, the U.S. EPA is planning to evaluate the most promising new technologies in several demonstration projects each year at Superfund sites across the nation. Testing may involve only one technology at a site or a set of them at various stages of the cleanup investigation. The U.S. EPA will choose the specific Superfund sites after a nationwide search that will match the effectiveness and compatibility of various technologies with specific wastes and conditions at the selected sites. The demonstrations will generate data on the cost and effectiveness of the technology.

GLOSSARY OF ACRONYMS

ARAR - Applicable or Relevant and Appropriate Requirements

CERCLA - Comprehensive Environmental Response, Compensation and Liability Act

EDD - Enforcement Decision Document

FS - Feasibility Studies

HRS - Hazard Ranking System

MCL - Maximum Concentration Limit

MCLG - Maximum Concentration Limit Goal

NCP - National Contingency Plan

NPL - National Priority List

PRP - Potentially Responsible Parties

QC - Quality Control

RA - Remedial Action

RCRA - Resource, Conservation and Recovery Act

RD - Remedial Design

RI - Remedial Investigation

RI/FS - Remedial Investigation/Feasibility Study

ROD - Record of Decision

SARA - Superfund Amendments and Reauthorization Act

SI - Site Inspection

SITE - Superfund Innovative Technology Evaluation

SWDA - Solid Waste Disposal Act

TSCA - Toxic Substances Control Act

USEPA - United States Environmental Protection Agency

REFERENCES

1. Comprehensive Environmental Response, Compensation and Liability Act, PL 96-510, Washington, DC, Dec. 1980.

2. Superfund Amendments and Reauthorization Act, PL 99-499, Washington, DC, Oct. 1986.

3. "U.S. EPA, The Superfund Progress Report," Washington, DC, Nov. 1986.

4. Federal Register, Vol. 51, No. 188, pp. 34534-34549, Washington, DC, Sept. 29, 1986.

5. Federal Register, Vol. 50, p. 47912, Washington, DC, Nov. 20, 1985.

6. Zuras, A. D.; Priznar, F. J. and Parrish, C. S., "The National Priorities List Process," Proceedings: Management of Uncontrolled Hazardous Waste Sites, Hazardous Materials Control Research Institute, Silver Spring, Maryland, Nov. 1985.

7. U.S. EPA, "Uncontrolled Hazardous Waste Site Ranking System--A User's Manual," HW-10, U.S. Environmental Protection Agency, Washington, DC, 1984.

8. "National Priorities List Fact Book - June 1986," U.S. EPA, HW-7.3, Washington, DC, June 1986.

9. "Guidance on Remedial Investigations Under CERCLA," U.S. EPA, EPA/540/G-85/002, Cincinnati, Ohio, June 1985.

10. "Guidance on Feasibility Studies Under CERCLA," U.S. EPA, EPA/540/G-85/003, Cincinnati, Ohio, June 1985.

11. "Superfund Innovative Technology Evaluation (SITE) Strategy and Program Plan," U.S. EPA, EPA/540/G-86/001, Washington, DC, Dec. 1986.

TABLE 1

COMPREHENSIVE LIST TO RATING FACTORS

HAZARD MODE	FACTOR CATEGORY	FACTORS		
		GROUND WATER ROUTE	SURFACE WATER ROUTE	AIR ROUTE
Migration	Route Characteristics	• Depth to Aquifer of Concern • Net Precipitation • Permeability of Unsaturated Zone • Physical State	• Facility Slope and Intervening Terrain • One-Year 24-Hour Rainfall • Distance to Nearest Surface Water • Physical State	
	Containment	• Containment	• Containment	
	Waste Characteristics	• Toxicity/Persistence • Hazardous Waste Quantity	• Toxicity/Persistence • Hazardous Waste Quantity	• Reactivity/Incompatibility • Toxicity • Hazardous Waste Quantity
	Targets	• Ground Water Use • Distance to Nearest Well/ Population Served	• Surface Water Use • Distance to Sensitive Environment • Population Served/Distance to Water Intake Downstream	• Land Use • Population Within 4-Mile Radius • Distance to Sensitive Environment
Fire and Explosion	Containment	• Containment		
	Waste Characteristics	• Direct Evidence • Ignitability • Reactivity • Incompatibility • Hazardous Waste Quantity		
	Targets	• Distance to Nearest Population • Distance to Nearest Building • Distance to Nearest Sensitive Environment • Land Use • Population Within 2-Mile Radius • Number of Buildings Within 2-Mile Radius		
Direct Contact	Observed Incident	• Observed Incident		
	Accessibility	• Accessibility of Hazardous Substances		
	Containment	• Containment		
	Toxicity	• Toxicity		
	Targets	• Population Within 1-Mile Radius • Distance to Critical Habitat		

Figure 1

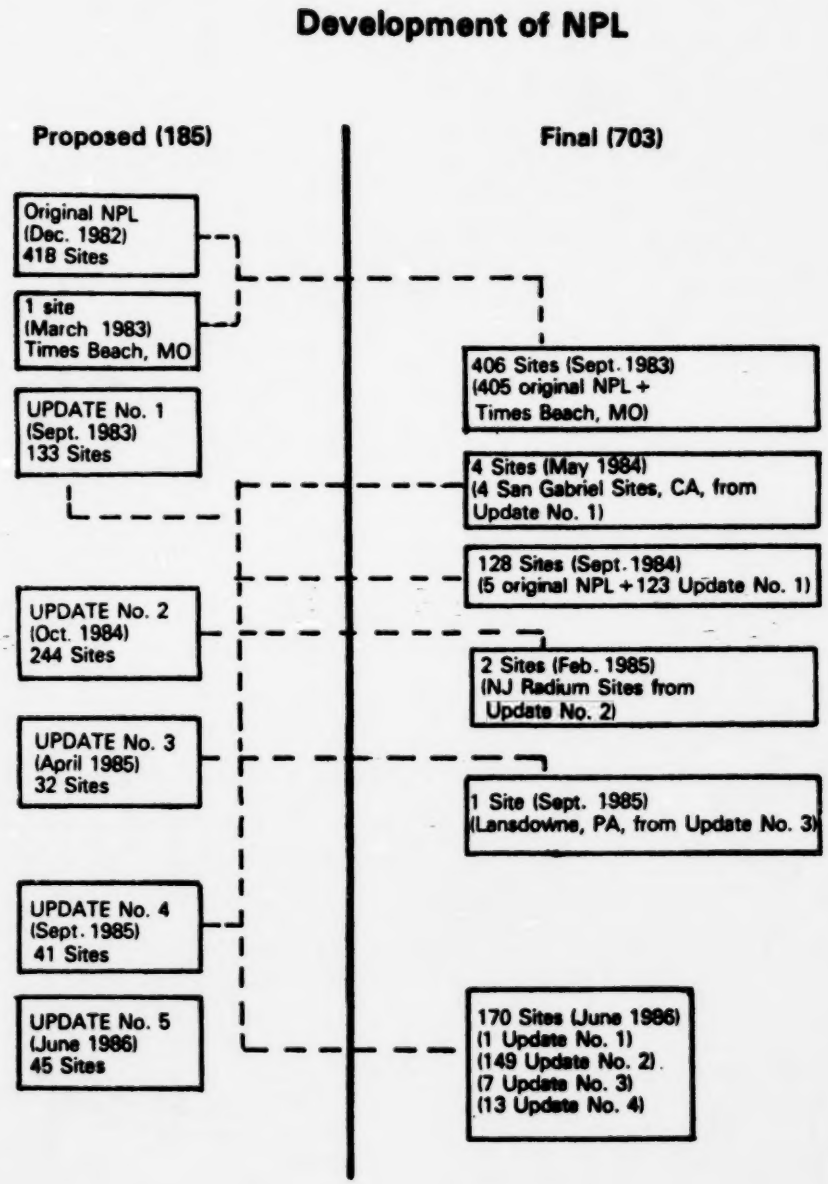

Development of NPL
Proposed (185)
Final (703)
Original NPL (Dec. 1982) 418 Sites
1 site (March 1983) Times Beach, MO
UPDATE No. 1 (Sept. 1983) 133 Sites
UPDATE No. 2 (Oct. 1984) 244 Sites
UPDATE No. 3 (April 1985) 32 Sites
UPDATE No. 4 (Sept. 1985) 41 Sites
UPDATE No. 5 (June 1986) 45 Sites
406 Sites (Sept. 1983) (405 original NPL + Times Beach, MO)
4 Sites (May 1984) (4 San Gabriel Sites, CA, from Update No. 1)
128 Sites (Sept. 1984) (5 original NPL + 123 Update No. 1)
2 Sites (Feb. 1985) (NJ Radium Sites from Update No. 2)
1 Site (Sept. 1985) (Lansdowne, PA, from Update No. 3)
170 Sites (June 1986) (1 Update No. 1) (149 Update No. 2) (7 Update No. 3) (13 Update No. 4)

Table 2

Final and Proposed NPL Sites Per State/Territory (By Total Sites) June 1986

State/ Territory	Final NPL	Proposed* Non-Fed	Proposed* Fed	Total
New Jersey	91	3	3	97
Michigan	56	10	0	66
New York	57	7	1	65
Pennsylvania	48	14	3	65
California	34	19	8	61
Florida	32	7	0	39
Minnesota	36	2	0	38
Ohio	27	3	0	30
Wisconsin	26	4	0	30
Indiana	23	5	0	28
Washington	19	3	6	28
Texas	21	3	2	26
Illinois	14	7	4	25
Massachusetts	21	0	0	21
Missouri	12	3	2	17
Colorado	12	1	2	15
Delaware	9	4	1	14
Iowa	6	7	0	13
New Hampshire	12	1	0	13
Virginia	7	5	1	13
South Carolina	10	2	0	12
Alabama	8	0	2	10
Kentucky	9	1	0	10
Utah	3	4	3	10
Arizona	5	4	0	9
Montana	7	2	0	9
Arkansas	7	1	0	8
Maryland	6	0	2	8
North Carolina	6	2	0	8
Puerto Rico	8	0	0	8
Rhode Island	8	0	0	8
Tennessee	7	0	1	8
Connecticut	6	1	0	7
Kansas	6	1	0	7
Louisiana	5	1	1	7
Maine	5	1	1	7
Hawaii	0	6	0	6
West Virginia	5	1	0	6
Georgia	3	1	1	5
Nebraska	2	2	1	5
Oklahoma	4	0	1	5
Oregon	4	0	1	5
Idaho	4	0	0	4
New Mexico	4	0	0	4
Mississippi	2	0	0	2
Vermont	2	0	0	2
Guam	1	0	0	1
North Dakota	1	0	0	1
South Dakota	1	0	0	1
Wyoming	1	0	0	1
Alaska	0	0	0	0
American Samoa	0	0	0	0
Commonwealth of Marianas	0	0	0	0
District of Columbia	0	0	0	0
Nevada	0	0	0	0
Trust Territories	0	0	0	0
Virgin Islands	0	0	0	0
	703	138	47	888

* Includes 45 Proposed Update #5 sites, 28 Proposed Update #4 sites, 24 Proposed Update #3 sites, 86 Proposed Update #2 sites, 2 Proposed Update #1 sites.

Table 3

Types of Activities at 888 Final and Proposed NPL Sites in Order of Occurrence June 1986

Surface Impoundments	Tanks, Below-Ground	Battery Recycling
Commercial/Industrial Landfills	Wood Preserving	Surface Mining Sites
Containers/Drums	Electroplating	Underground Injection
Municipal Landfills	Waste-Oil Processing	Drum Recycling
Manufacturing Other Than Chemical	Ore Processing/Refining	Road Oil
Spills	Surface Water Outfalls	Sand and Gravel Pits
Chemical Processing/ Manufacturing	Military Ordnance	Sink Holes
Leaking Containers	Solvent Recovery	Subsurface Mining Sites
Tanks, Above-Ground	Open Burning	Explosive Disposal/ Detonation
Waste Piles	Landfarm/Land Treatment	Laundry/Dry Cleaning
Ground-Water Plumes	Incinerators	Tire Storage/Recycling
	Military Testing/ Maintenance	

Figure 2

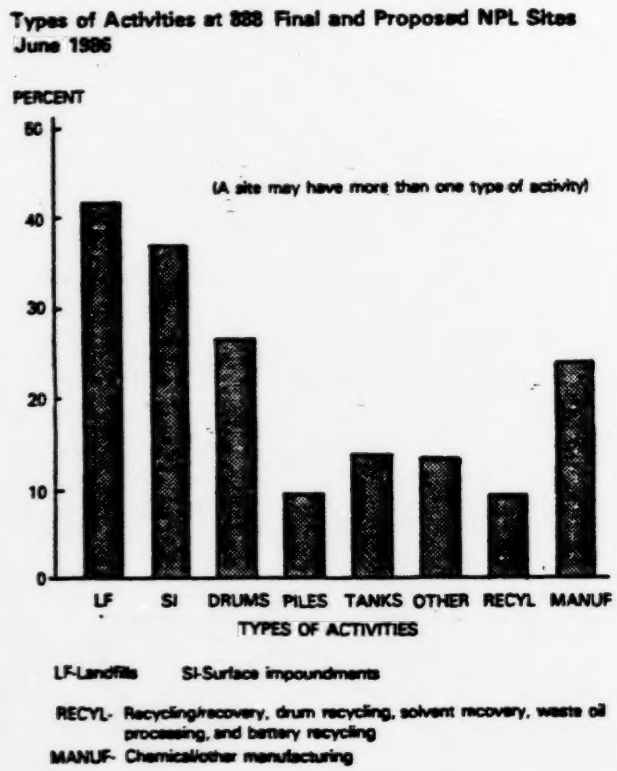


Figure 3

Observed Contamination at 888 Final and Proposed NPL Sites
June 1986

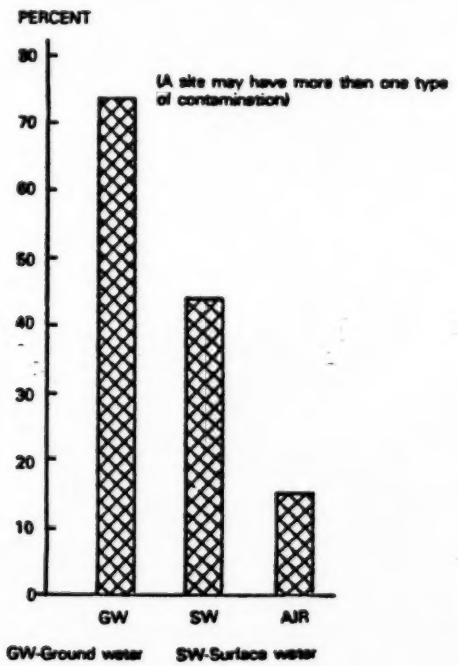


Figure 4. Remedial Investigation Process

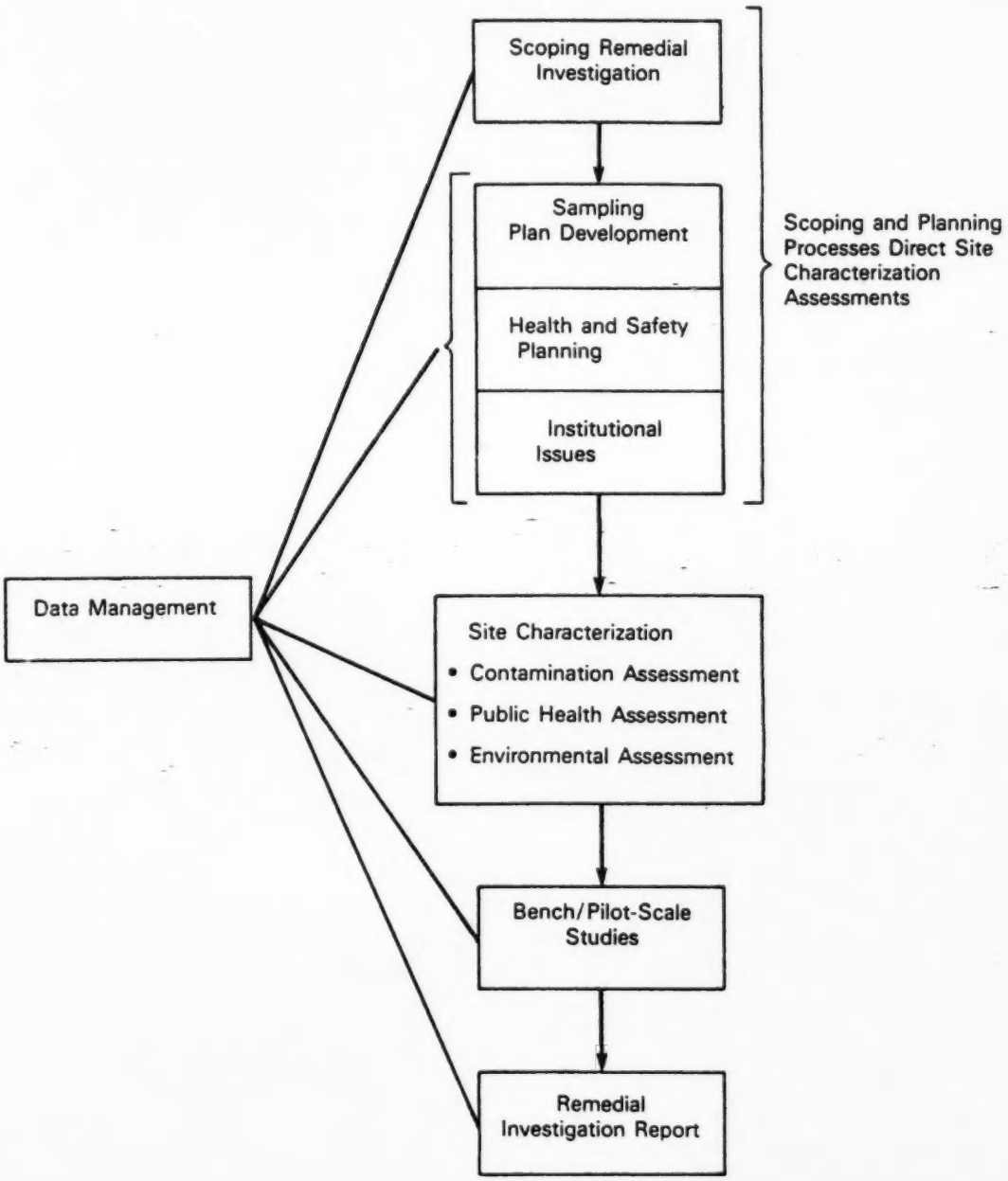
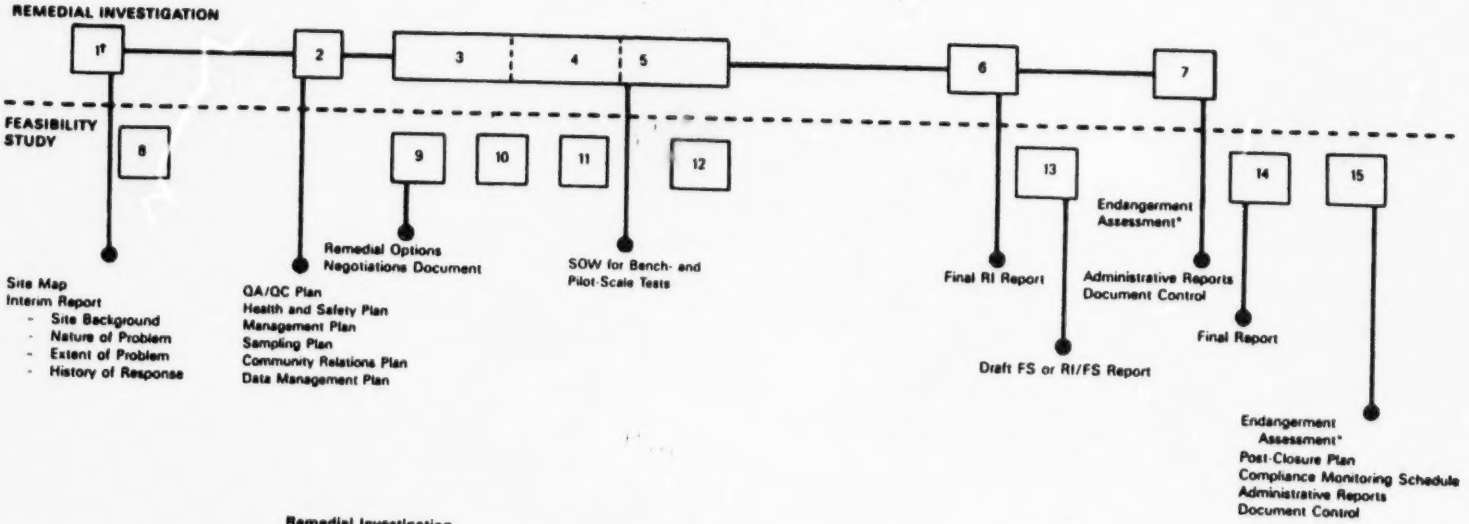


Figure 5. RI/FS Process



Remedial Investigation

Model Statement of Work for Remedial Investigations

Task #1 - Description of Current Situation

Task #2 - Plans & Management

Task #3 - Site Investigation

Task #4 - Site Investigation Analysis

Task #5 - Laboratory & Bench-Scale Studies

Task #6 - Reports

Task #7 - Community Relations Support

Guidance Document for (A) Remedial Investigations Under CERCLA

CH 1 - Introduction

CH 2 - Scoping

CH 3 - Sampling Plan Development

CH 4 - Data Management Procedures

CH 5 - Health and Safety Planning for Remedial Investigations

CH 6 - Institutional Issues

CH 7 - Site Characterization

CH 8 - Pilot and Bench Studies

CH 9 - Remedial Investigation Report Format

Feasibility Study

Model Statement of Work for Feasibility Studies

Task #8 - Description of Proposed Response

Task #9 - Preliminary Remedial Technologies

Task #10 - Development of Alternatives

Task #11 - Initial Screening of Alternatives

Task #12 - Evaluation of Alternatives

Task #13 - Preliminary Report

Task #14 - Final Report

Task #15 - Additional Requirements

Guidance Document for (B) Feasibility Studies Under CERCLA

CH 1 - Executive Summary

CH 2 - Develop a Range of Remedial Alternatives

CH 3 - Conduct a Detailed Technical Evaluation

CH 4 - Evaluate Institutional Requirements

CH 5 - Evaluate Protection of Public Health Requirements

CH 6 - Evaluate Environmental Impacts

CH 7 - Cost Analysis

CH 8 - Summarize Alternatives

CH 9 - Feasibility Study Report Format

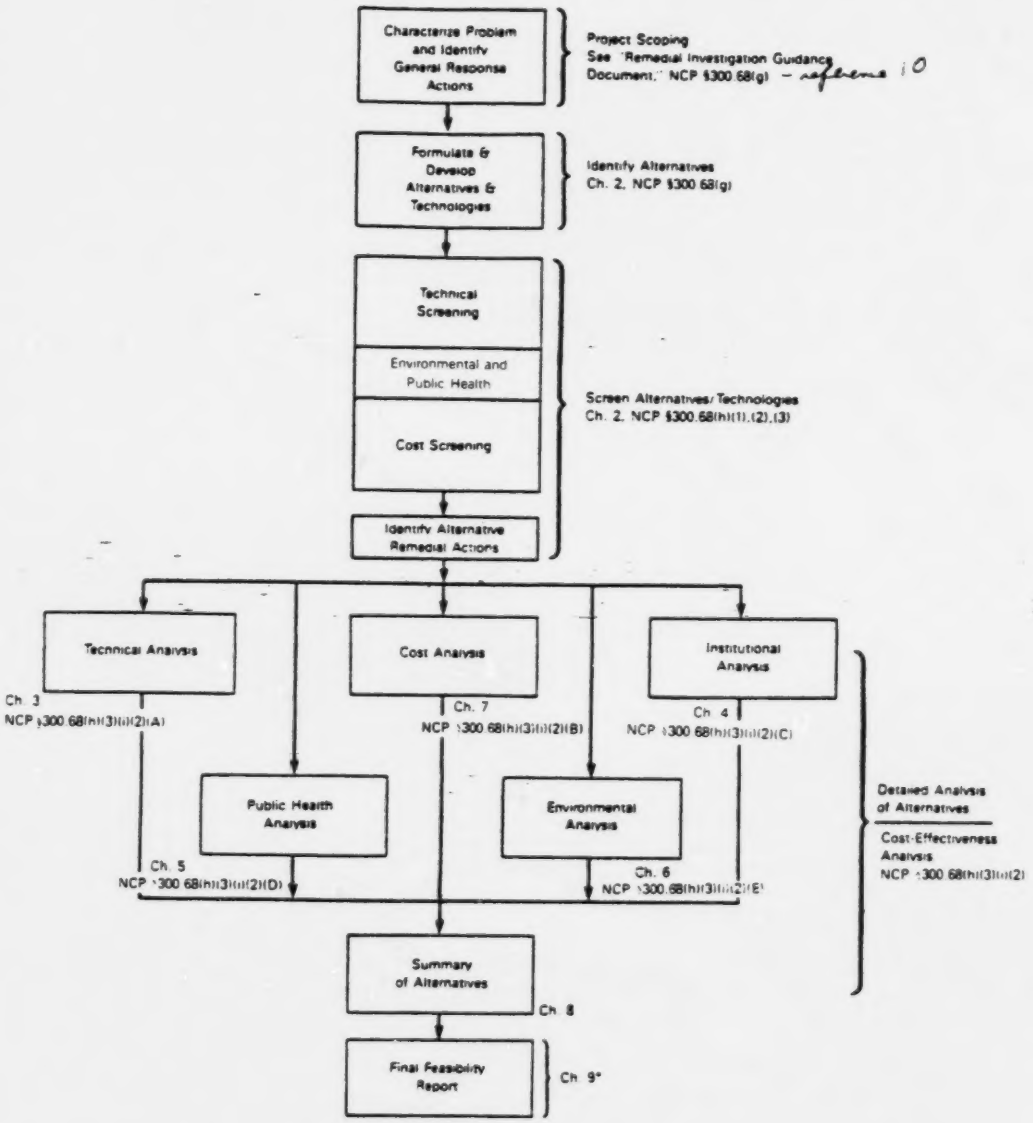
† Numbers in the boxes refer to tasks described in the Model Statement of Work for RI/FS under CERCLA Guidance issued February 1985. See Appendix A.

* Endangerment assessments may be prepared at any point in the RI/FS process in support of enforcement actions.

(A) Reference 9

(B) Reference 10

Figure 6. Feasibility Study Process



Note: NCP sections identified refer to those cited in the Federal Register, July 16, 1982.

*Not specified sections of the NCP

Figure 7

Sites Using Each Treatment Technology

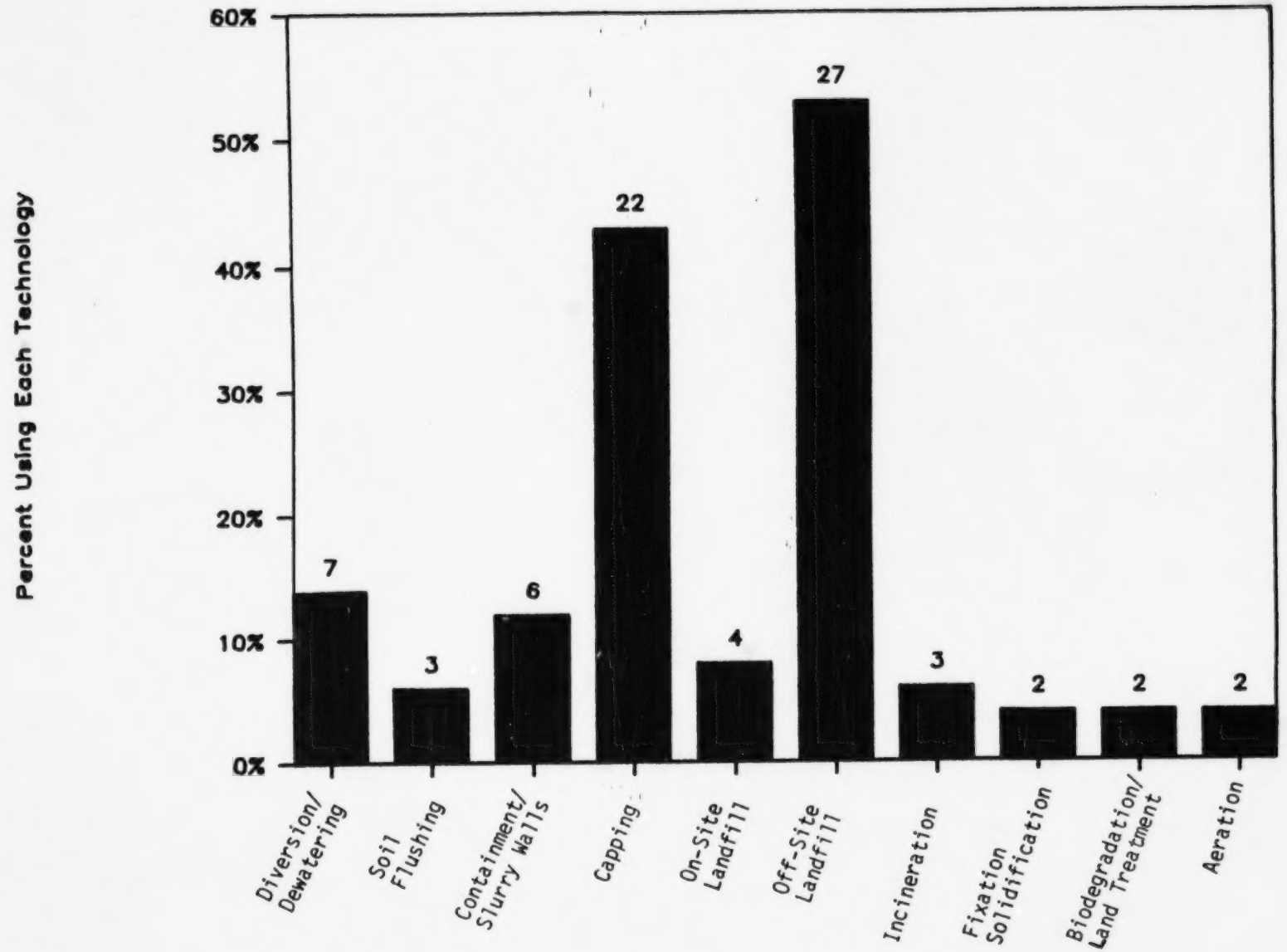


Table 4

Substances Most Frequently Found at Superfund Sites

SUBSTANCE NAME	SITE FREQUENCY
TRICHLOROETHYLENE (TCE)	297
1,1,2-TRICHLOROETHYLENE	297
LEAD (PB)	273
TOLUENE	235
BENZENE	204
CHLOROFORM	179
POLYCHLORINATED BIPHENYLS, NOS	159
1,1,2,2-TETRACHLOROETHENE	145
ZINC AND COMPOUNDS, NOS (ZN)	137
1,1,1-TRICHLOROETHANE	137
CADMIUM (CD)	132
ARSENIC	127
CHROMIUM AND COMPOUNDS, NOS (CR)	125
PHENOL	124
ETHYLBENZENE	106
XYLENE	106
1,2-TRANS-DICHLOROETHYLENE	104
COPPER AND COMPOUNDS, NOS (CU)	98
METHYLENE CHLORIDE	93
CHROMIUM	80
1,1-DICHLOROETHANE	75
MERCURY	75
CYANIDES (SOLUBLE SALTS), NOS	74
1,1-DICHLOROETHENE	71
VINYLCHLORIDE	65
CARBON TETRACHLORIDE	63
CHLOROBENZENE	62
1,2-DICHLOROETHANE	61
NICKEL AND COMPOUNDS, NOS (NI)	59
HEAVY METALS, NOS	57
PENTACHLOROPHENOL (PCP)	52
NAPHTHALENE	45
TRICHLOROETHANE, NOS	40
METHYL ETHYL KETONE	39
VOLATILE ORGANICS, NOS	34
MANGANESE AND COMPOUNDS, NOS (MN)	29
IRON AND COMPOUNDS, NOS (FE)	28
BARIUM	28
ACETONE	27
CHROMIUM, HEXAVALENT	26
ARSENIC AND COMPOUNDS, NOS (AS)	25
DICHLOROETHYLENE, NOS	25
PHENANTHRENE	25
BENZO A PYRENE	25
1,1,2-TRICHLOROETHANE	24
ANTHRACENE	21
STYRENE	21

SUBSTANCE NAME	SITE FREQUENCY
PYRENE	21
CREOSOTE	21
DDT	21
SULFURIC ACID	20
SELENIUM	20
LINDANE	20
TETRACHLOROETHANE, NOS	19
1,1,2,2-TETRACHLOROETHANE	19
WASTE OILS/SLUDGES	19
BIS(2-ETHYLHEXYL)PHTHALATE	18
ACID, NOS	18
FLUORENE,NOS	17
BENZO(J,K)FLUORENE	17
RADIUM AND COMPOUNDS, NOS (RA)	16
ETHYL CHLORIDE	16
ALUMINUM AND COMPOUNDS, NOS (AL)	14
DICHLOROETHANE, NOS	14
TRICHLOROFLOUROMETHANE	14
DICHLOROBENZENE, NOS	13
URANIUM AND COMPOUNDS, NOS (U)	13
ACENAPTHENE	13
TRINITROTOLUENE (TNT)	13
CHLORDANE	13
RADON AND COMPOUNDS, NOS (RN)	12
CIS-1,2,DICHLOROETHENE	12
CIS-1,2-DICHLOROETHYLENE	12
CIS-DICHLOROETHYLENE	12
1,2-DICHLOROETHYLENE	12
ASBESTOS	12
TRIBROMOMETHANE	12
ANTIMONY AND COMPOUNDS, NOS (SB)	11
HYDROCARBONS, NOS	11
CHLOROMETHANE	11
DI-N-BUTYL-PHTHALATE	11
HEXACHLOROBENZENE	11
TETRAHYDROFURAN(I)	11
DDE	10
DIOXIN	10
AMMONIA	10
DIELDRIN	10
CHRYSENE	10
CRESOLS	9
2,4-DINITROTOLUENE	9
HEXACHLOROCYCLOPENTADIENE (C56)	9
METHYL ISOBUTYL KETONE	9
WASTE SOLVENTS	9

PUBLICATION LIST OF SUPERFUND TECHNOLOGY REPORTS

SLURRY TRENCH CONSTRUCTION FOR POLLUTION MIGRATION CONTROL. EPA/540/2-84/001

CASE STUDIES OF REMEDIAL RESPONSE AT HAZARDOUS WASTE SITES, VOL.I, EPA/540/2-84/002

CASE STUDIES 1-23: REMEDIAL RESPONSE AT HAZARDOUS WASTE SITES, VOL.II, EPA/540/2-84/002B

REVIEW OF IN-PLACE TREATMENT TECHNIQUES FOR CONTAMINATED SURFACE SOILS, VOLUME I TECHNICAL EVALUATION, EPA/540/2-84/003A

REVIEW OF IN-PLACE TREATMENT TECHNIQUES FOR CONTAMINATED SURFACE SOILS, VOLUME 2 BACKGROUND INFORMATION FOR IN SITU TREATMENT, EPA/540/2-84/003B

MODELING REMEDIAL ACTIONS AT UNCONTROLLED HAZARDOUS WASTE SITES, EPA/540/2-85/001

COVERS FOR UNCONTROLLED HAZARDOUS WASTE SITES, EPA/540/2-85/002

GUIDANCE ON REMEDIAL INVESTIGATIONS UNDER CERCLA, EPA/540/G-85/002

GUIDANCE ON FEASIBILITY STUDIES UNDER CERCLA, EPA/540/G-85/003

HANDBOOK: DUST CONTROL AT HAZARDOUS WASTE SITES, EPA/540/2-85/003

LEACHATE PLUME MANAGEMENT, EPA/540/2-85/004

HANDBOOK: REMEDIAL ACTION AT WASTE DISPOSAL SITES (REVISED), EPA/625/6-85/006

HANDBOOK FOR STABILIZATION/SOLIDIFICATION OF HAZARDOUS WASTE, EPA/540/2-86/001

SYSTEMS TO ACCELERATED IN SITU STABILIZATION OF WASTE DEPOSITS, EPA/540/2-86/002

MOBILE TREATMENT TECHNOLOGIES FOR SUPERFUND WASTES, EPA/540/2-86/003F

SUPERFUND TREATMENT TECHNOLOGIES: A VENDOR INVENTORY, EPA/540/2-86/004F

SUPERFUND INNOVATIVE TECHNOLOGY EVALUATION (SITE) STRATEGY & PROGRAM PLAN, EPA/540/G-86/001

FOR ORDERING INFORMATION CONTACT:

ORD PUBLICATIONS
US EPA
26 W. ST. CLAIR STREET
CINCINNATI, OHIO 45268

PHONE: (513) 569-7562